LUBRICATION

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EDITORIAL DEPARTMENT

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We invite correspondence from all those interested.

Those who fail to receive Lubrication promptly, will please notify us at once and will confer a favor by promptly reporting change of address.

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GROWTH OF "LUBRICATION"

DURING the last year the circulation of this magazine has grown very remarkably and a short resumé of our purpose in publishing it might not be out of place. It is our intention to have this little book show the possible savings that can be effected by careful investigations of different lubricating problems, to show by particulars of tests the savings actually effected in various cases which have come to our attention; and to illustrate the value of Texaco Lubricating Oils in particular.

Taking into account, both the rapid growth of the mailing list, and the number of requests for information received, it appears that this book is fulfilling its mission, and, we hope, is aiding many in their study of the subject.

Possibly you have some engineer friend, who would be pleased to receive *Lubrication*. If so, send his name to us, or better still, acquaint him with your purpose and let him fill out the enclosed postal and mail it.

This book, first published for use among the employees of The Texas Company, found its way outside, and by degrees, requests became so insistent and numerous as to make it necessary to add materially to its scope, thus making it a magazine of its present standard. It has been favorably received wherever it has gone and we feel that its progress is sufficient evidence of its value to justify its continued publication and circulation among those interested.

SELECTING THE RIGHT OIL

WITH the advent of new mechanical feeds and the amount of serious study given to lubricating devices, great improvements have been made in the past few years. But this, however, has not reached the point where a clear understanding of the relation between mechanical conditions and quality or kind of oil can be demonstrated. To be sure, much has been accomplished with oil economy in mind, but the period of study has not been long enough to develop the use of these devices so that lubrication can reach its proper efficiency.

If it were possible to remove practically all friction by means of ideal lubrication, the life of power generators and all machines driven by power would be greatly increased, and a much higher degree of mechanical efficiency attained. Practically all the power generated would be utilized and the amount of repairs almost nil. But this is not the case, owing partly to the great difference in mechanical conditions, and partly to the lack of fitness or suitability of the lubricants used. Further, the economic possibilities of well-chosen lubricants upon friction are commonly overlooked; due, no doubt, to the fact that lubricating oils are not usually classed with reference to the work to be accomplished.

It was formerly the practice among many manufacturers to decide upon the lubricant necessary for their use with little consideration as to its fitness for the work. By this practice fairly good oils were sometimes selected, but the best were often rejected, either because of some salesman's persuasive ability or the utter lack of appreciation (on the part of those using and selecting lubricants) of the importance of certain kinds of oil for certain purposes. This has been demonstrated time and time again by the frequent practice of "cutting down" or mixing of cylinder and engine oils for external lubrication, either because the engine oil was too light or the cylinder oil too heavy for the work required. By this practice, the necessary body of oil can be obtained without the mixture possessing any of the properties essential for economical lubrication. With the present day methods of manufacturing lubricating oils, it is possible to make them in such a way, that the results of their application are known beforehand; and it is also possible for an expert engineer trained in power-saving work to judge within a few per cent. of the exact reductions which will be made upon particular machines against any other oil in use.

In selecting an oil to do a certain kind of work upon a certain machine, the fact often develops that upon a machine operating under equal working conditions, oils showing the same chemical analysis act differently from a lubricating standpoint.

This makes it of the utmost importance to understand the fact that oil selected under test is the only sure way of securing the proper oil. Provided, of course, that the test itself is conducted in such a manner as to show the actual influence of each oil upon frictional resistance. In other words, what is needed in this case is a practical test made in such a way that the oil is operating under working conditions during the ordinary course of business; but sufficient arrangements should be made to develop with proper accuracy the bearing or cylinder conditions, the amount of oil used, the extent and character of the lubrication (shown in the condition of the machines after the test) and any other points which are necessary to demonstrate the actual facts. It is true that a great deal of oil is bought under so-called tests. The methods

adopted in these tests, however, make it absolutely impossible to determine with any degree of accuracy the influence of the oil upon frictional resistance and, therefore, equally impossible to make a proper selection.

Probably one of the most widely used of these so-called tests is the one in which the oils under consideration are given to the engineer or the operator of the machine with instructions to observe the effect of the oil and to report upon the one which proves the best. The machine operator is interested primarily in the output of the machine; in keeping this output to the required point, and, if possible, pushing it beyond that point, particularly where such extra production means a bonus. He is not, however, interested in the saving of wear-and-tear upon the machine, in the conservation of the value of the machine, in lengthening its life, etc. Furthermore, he is not equipped with any means of taking accurate measurements, such as a reduction of one or two degrees in bearing temperature, a difference of 3% or 4% in quantity, or anything of that kind; so that it is no wonder that his report usually takes the form of a general expression of opinion such as "all right," "no difference in the working," "not quite so good," etc. After all of which, the information secured by the manufacturer on account of such report is practically nil.

No measure can be made as to the value of a product, unless its effect upon saving, production, etc., can be demonstrated and actually known. There can be no question as to whether oils will work. All oils will work, that is, will get between the metal surfaces and for a time (longer or shorter) prevent them from seizing. The only reason for the test is to find out what oil will do the work with the least expenditure of energy; that is, with the greatest reduction of friction and with the least consumption of oil.

To determine such matters exactly and accurately so that the information can be depended upon, and the extent of the economy determined, it is necessary for tests to be conducted which have at least the same degree of accuracy expected by the engineer in his other power plant tests, and probably somewhat closer figuring because of the smaller units dealt in. The reason for the laxness in regard to the testing of lubricating oils lies undoubtedly in the fact that the value of economy in lubrication, rather than economy in oil expense, has not been understood. It is not easy without careful and accurate tests and equally careful figuring to appreciate the effect upon the coal bill of a reduction of a few per cent. of the frictional resistance in a plant. It is not particularly easy to appreciate the effect of such reduction upon the life of the machinery. Consequently, the necessity for careful and accurate testing is frequently not understood. When, however, it is realized that the money value of a 10% reduction in the total H. P. requirement of a manufacturing plant will frequently more than equal its bill for lubricants for an entire year, the possibilities which lie behind careful testing of oil and the buying of oil upon proper tests, can be better appreciated. Furthermore, the actual cost of a proper lubricant is usually not very much greater than the cost of a cheap lubricant for the same purpose.

In many cases, an oil properly selected by test for the work which it has to do, will represent a saving in consumption, in friction, and in wear-and-tear, more than sufficient to offset an increase of two or three times the price per gallon in the oil.

Selecting oil by specification is an absurdity under present-day conditions of refining and manufacturing. Oils meeting the same specification may be very different in their lubricating quality, the arbitrary physical

tests used in such specification having little to do with the effect of the oil when in use. Only one successful method has been discovered as yet for the buying of oil in such a way as to secure economical lubrication. That method is the one expressed above, of selection by careful and accurate tests showing the bearing temperatures and the effect of each oil upon same, the consumption and its relation to the price; the length of time in which the oil can be kept in use, etc. Such tests will lead to the selection of oil upon a basis that will enable the economies to be transferred into the balance sheet, not only in their effect upon the oil bill, but in their much larger effect upon the total power requirement of the whole establishment.

TEXACO CRATER COMPOUND

THE difficulty encountered by steam shovel and dredge men in properly lubricating their cables has been such that chains are frequently allowed to run unlubricated, and replaced as they break. Most of the lubricants offered have simply provided a coating to the outer surface of cables.

This coating naturally offers some resistance to friction between the outer surface of the cable and the carriage drums, etc. But it has been proven that friction at this point is less detrimental to the life of a cable than that caused by the rubbing together of the inner strands. Thus, in order to provide perfect lubrication, a lubricant of sufficient body and of great adhesiveness must be used, capable of working between each strand of the cable and of offering a good coating to them.

Realizing the great waste due to this condition, The Texas Company has placed on the market a lubricant of great adhesive power, able to resist the action of water, both salt and fresh, having a body which will enable it to work its way between the strands and thus lubricate each one separately. This compound was tested (in one case) under the following conditions.

A cantilever crane used for unloading coal from ship to cars and storage pile, and reloading from storage pile to cars and barges, has a number of cables, one of which is subjected to hard usage. There are four $\frac{3}{4}''$ cables in all, making 1,990 feet of this size cable; two $\frac{5}{8}''$ cables, 285 feet long, and 286 feet of $\frac{7}{8}''$ cable on this machine.

No. 1—$\frac{3}{4}''$ cable, 550 feet long—was given such unusual wear as to make necessary its frequent renewal. This cable is composed of six strands of 19 wires each, with a center of six strands of 7 wires each, the center of the inner strand having 3 cords of hemp. It is wound on a 4 ft. grooved driving drum, from there leading to a 36″ drum on the carriage. Between the two drums the cable makes five turns, both at right angles, and through a complete half circle. The greatest diameter of the sheaves is 32″.

The bucket weighs 3.15 tons, and holds 1.63 tons, making a total weight of 4.78 tons. The 36″ drum on the carriage has 18″ drums on both sides of it, from which $\frac{5}{8}''$ cables are connected to the bucket, reducing the weight placed on cable No. 1, when lifting the bucket from the ship, to 2.39 tons. The distance through which this weight is carried is usually 50 feet, although it varies, depending upon the depth of the coal in the ship. Lifting the bucket, it must be moved with its carriage a distance of 175 feet across the cantilever arms.

The aggregate time for the round trip is forty seconds.

The wear on this cable necessitated renewal every two to four weeks, depending upon the number of tons of coal loaded and unloaded. Upon examination it was found that no one particular section was worn, the wear being about the same through the entire length, wires being broken indiscriminately in all the outside strands; the breakage being caused by the friction among the wires and strands due to the number of turns rather than to the weight lifted.

Texaco Crater Compound proved very successful, under this severe service, as is shown below:

	Tons lifted before cable broke
Cable lubricated with gear grease and car oil mixed.	43,364 tons
Cable lubricated with Texaco Crater Compound	57,348 tons

Increase of 3,984 tons or 32.24%.

Both cables were made by the same manufacturer, of the same number of strands, and of equal circumference.

An examination of the cable lubricated with the mixture of gear greases and car oil showed that the lubricant did not work into the strands of the cable, nor offer any internal resistance to friction, although the result produced by its use was better than that of the usual tarry cable grease, which acts more as a preservative against dust than a lubricant.

With the second cable lubricated with Texaco Crater Compound, it could be readily seen where the oil worked in between the strands, lubricating and preventing friction between the wires comprising them, thereby, increasing the life of each, and of the cable as a whole. It furthermore filled all space around the outside of the cable, making it look like a round rope, acting in this way, to a certain extent, as a cushion.

Ample lubrication was obtained by applying Texaco Crater Compound every two or three days compared to an application of three or four times daily of our competitor's grease.

The greases and oils generally adopted for chain lubrication have not, as a rule, shown in practical use that any results have been attained in permanently reducing friction. The total cost for the use of such oils and greases has been considered unimportant until we introduced our Texaco Crater Compound, when a comparison of results has shown that the former cost, using the inefficient materials, was exceedingly high and results were very unsatisfactory. The chief difficulty with the greases, black oils and chain dressings is their general inability to adhere to the chain. An excellent example, and one that has been very many times repeated, is a case showing the success of Texaco Crater Compound on the main chain of a dredge which was doing some very heavy work on the Hudson River. This dredge was fitted with an extra heavy bucket, and a special chain was supplied by a large Western chain company. Previously, on the chains of this dredge, a graphite grease was used as a lubricant. In their judgment, this was the best material that the owners could procure for work of this kind. The life of the chains, at the very outside, was not over eleven months, which was considered a very substantial performance under the severe conditions of operation. It required very considerable time to apply the graphite grease. A lubricant of some kind was necessary, and to keep the conditions as good as it was possible to have them, a thick application of the graphite grease was required two or three times a day. The action of the chain in running over the pulleys and

plunging into the salt water, washed off the grease, and required the constant reapplication of the lubricant in order to keep the chain from wearing out unnecessarily.

Our Texaco Crater Compound was shown to the owner of the dredge and as the dredge was down for repairs and a new chain was being put in, they started off with the Crater Compound. The chain was carefully watched during the first period of four hours, as this was the interval of time at which it was found necessary, on previous chains, to reapply the lubricant. At the end of this time the condition of the Crater Compound was found to be nearly the same as when first applied, each link of the chain having a good coating of the oil. While carefully watching the performance of the chain, it was found that it was not necessary to put on any more of the Crater Compound until after a continuous use of twenty-four hours, at which time it was considered advisable to reoil the chain. Comparison of this service with that of the average run of four hours for each application of the graphite grease shows a saving in the actual amount of material used of approximately 83%, or a saving in cost of about 50%. Crater Compound, as each inspection showed, withstood the action of the salt water and air longer than the competitive graphite grease, and at the same time afforded much better lubrication than anything else that these people had ever seen or used.

When this case was referred to the chain manufacturers who had furnished the special chain used on this dredge, they expressed themselves as being exceedingly interested, stating that they intended to personally send out this record to the users of all of their chains, as it was of considerable importance to them that their customers should have the benefit of any material that had proven to be as efficient as Texaco Crater Compound.

In another case, where the Crater Compound was used on a Sand Sucker Dredge, the Chief Engineer in charge of the dredge was very enthusiastic in writing to us regarding its sticking qualities, which he states are superior to anything else he has ever tried throughout all the years he has spent in dredge work. He says he has given various compounds some of the most severe tests ever made in dredge work, and that his statements in regard to the Crater Compound are not haphazard, but are based upon the results of very considerable experiment. Details which he gives are as follows:

The Crater Compound was applied on a train of five gears, ranging from 6″ diameter, 10″ face, 3″ pitch, to 1″ diameter and 12″ face. These gears operate the cutter on the suction tube. This cutter is rotated at 180 R.P.M., and requires 450 H. P., as it is working in hard clay ranging in depth from six to fifteen feet. The train of gears, at times, is practically submerged in water, caused by leakage from the ball and socket joints on the upper part of the suction tube. On the train of gears operating the cutter, one gallon (or 8 lbs.) for the five gears is sufficient to coat each with a heavy film of the Compound, which is sufficient to run seven days when little leakage occurs; however, under extreme wet conditions the Crater Compound lasts about two or three days before the film begins to break. But on each chain of gears operating the drums, one pint or one pound per week is ample. Before Texaco Crater Compound was applied, the best results were obtained with a pitch compound, costing the same as Crater Compound, but requiring two-thirds more to do the same work.

The use of Crater Compound, therefore, on this dredge has resulted in less labor in application, and in

much better performance at a cost of only one-third of that of the former product.

The letters below tell as much as we can of the success obtained through the use of Texaco Crater Compound:

P. SANFORD ROSS, INC.

Jersey City, N. J.

February 28th, 1913.

THE TEXAS COMPANY,

17 Battery Place, New York.

Gentlemen:

In reference to your Texaco Crater Compound, we wish to say that we have been using this oil as a chain and cable dressing for the last eight months. We find that this Crater Compound is superior to anything that we have ever used before or had called to our attention for this purpose. Its great adhesive properties make it very well suited for this class of work. The chains and cables are working in salt water, which does not seem to have any effect whatever on the Crater Compound. We consider that *the life of the chains and cables has been considerably lengthened*, due to the protection against wear afforded them by Crater Compound. *The cost of lubricating our chains and cables is considerably reduced*, owing to the lasting qualities of your Crater Compound. We consider it the best chain and cable dressing on the market.

Yours very truly,

P. SANFORD ROSS, INC.,

(Signed) Per Roland T. Ross.

[Italics are ours.]
Editor

A later letter from the same firm.

August 14th, 1913.

Gentlemen:

It may interest you to hear a report from us on the Crater Compound furnished by your Company.

We have used this oil on the chains on our dipper dredge ever since she came out, which was about March, 1912. The hoisting chain on this machine is rigged up for a double purchase, from which it gets about twice the wear of an ordinary dredge chain.

We are glad to see that this chain up to the present time shows very little wear, proving to us quite conclusively *that Crater Compound must be an excellent lubricant for dredge chains.*

Yours truly,

P. SANFORD ROSS, INC.,

(Signed) Per P. Sanford Ross, Jr.

DEVELOPMENTS IN LUBRICATION, WITH SPECIAL REFERENCE TO THE USE OF SOUTHERN CRUDES

By William F. Parish

Manager Lubricating Division, The Texas Co., 17 Battery Place
New York City, N. Y

Delivered before the National Association of Cotton Manufacturers, Atlantic City, New Jersey, October 2, 1913

THE value of scientific observations in regard to the lubricating properties of mineral oils upon testing machines in the laboratories of our large technical schools is not open to question. These tests, when properly conducted and when the observations are rightly interpreted, lead to conclusions that can be of very great benefit to manufacturers in general. Outside of the laboratory, in the average mill or shop, it is quite possible to secure results showing the actual frictional losses due to the use of various oils upon single machines or groups of machines, and these results, if the tests are controlled by careful, trained observers, will be of such a nature that reliable data will be secured in regard to the actual frictional effect with each set of lubricants tested. Quite naturally, in working in the shop or mill under practical conditions, many factors influence these results. These factors are not, in nearly all cases, possible to control or eliminate; for instance, in cotton mill testing the influence exerted upon the power by the relative humidity and the temperature is very strong.

In a laboratory where a single testing machine is under observation, all influences can be controlled, and the results obtained on such a machine, operated under test conditions, have a considerable scientific value.

As to the general laws governing lubrication, these have been well established. The rule is, that within limits a reduction in the viscosity of a lubricant will bring about a reduction in the co-efficient of friction or a reduction in temperature and in lost power. Most of the resistance or lost power in running machinery is caused by the internal friction or the fluid friction in the lubricant used, assuming that an average condition with an average oil is under consideration. It is only occasionally, through the use of a very improper oil or lack of feed of a proper oil, that actual metal wear on properly constructed bearings takes place. Wherever bearings are flooded or where a proper working oil film is maintained, a very large proportion of the frictional loss is directly due to the internal, fluid friction of the oil itself, and this can be influenced one way or another along certain prescribed lines.

The results of twenty power tests showed that the average reduction in the total power of fifteen textile mills was 8.90%, the lowest reduction being 2.50% and the highest 15.90% of the total load. The greatest proportion of this saving was due largely to the difference in fluid friction between the different sets of oils tested.

In working entirely with Paraffine Base Oils, the co-efficient of friction or the power factor is influenced directly in proportion to the rise and fall of the viscosity of the oil used, always within the limits of speed and pressure. Working with oils made from the new Southern or Texas Asphaltic Base Crudes the same general rule also applies.

The following tests represent both scientific and practical tests and investigations which show that, while

the general law of the relation of viscosity to power is applicable to lubricants made from any one crude, or classification of crude, a modification is necessary when tests on oils made from the Paraffine Base Crudes are compared with tests on oils made from the new Texas Base Crudes.

That is, while a lower power reading using Paraffine Base Oils can be obtained under certain conditions with a Paraffine Base Oil, of lower viscosity, the same lower reading can be obtained by using a higher viscosity Texas Asphaltic Base Oil. This technical feature of the Texas Base Oils is of the utmost importance, not only from a scientific, but from a practical standpoint.

These latter oils have been developed by a method employed by one of the most important refiners of that Crude, and wherever these particular oils are necessary to be described in this paper they will be referred to under the general trade name Texaco with the name of the particular oil as a means of identification for any future investigators.

The following case will indicate quite clearly the modification of the original established rule referred to above.

Case No. 1

Scientific tests upon a Friction Testing Machine were made for the purpose of determining the general influence upon the power of the machine with different rates of flow of the lubricating oil. Two (2) sets of oils were used for the trial, one of these oils being made from Pennsylvania Paraffine Base Crude, the other from a Texas Asphaltic Base Crude. The following is a general description of the testing machine.

This machine consists of a shaft carried between two bearings and driven by a belt from an overhead line shaft. The shaft of the machine extends beyond one of the bearings and on the overhanging part is a pendulum which contains the test brasses. To these brasses the pressure is exerted by two heavy springs placed one inside the other. The magnitude of the total pressure on the bearing is indicated by a pointer which moves along a graduated scale on the pendulum. The deviation of the pendulum is measured on a graduated arc fastened to the frame of the machine. The bearing temperature is shown on a thermometer which is placed in a hole bored through the bearing into the babbitt metal. This hole is filled with oil in which the bulb of the thermometer is submerged.

The oil feed apparatus used in the test consisted of a tank mounted on a platform scale, the oil being supplied to the bearings through a flexible rubber tubing which was connected to branches of piping leading to the brasses. Inserted in this piping were two small stop-cocks which were used to control the rate of flow.

Before the series of tests, which are about to be described, were made, the machine was thoroughly cleaned and calibrated. The machine was then run for several hours with only the weight of the pendulum on the bearings so that the conditions of temperature and speed would be noted. After they were found to be constant, the flow of the oil was regulated to a minimum until it approached a condition of intermittent oiling. When the desired regulation of feed was obtained, the regular tests were made by taking the following readings at ten minute intervals for one hour:

- Time
- Weight of oil and reservoir on scale
- Deflection of pendulum from normal position
- R.P.M of shaft (kept constant)
- Bearing temperature
- Room temperature

After the expiration of this hour test, the flow of oil was increased until

a noticeable decrease of deflection from the previous deviation was secured. Then the machine was allowed to acquire constant bearing temperature, after which the second group of readings at ten minute intervals was taken. To get adequate data for each bearing pressure, at least six of these runs had to be performed.

These series of readings were made exactly the same on the two samples of oil under consideration, the first of these samples being an oil made from a Paraffine Base Crude, known as Pennsylvania Oil, and the second known as Texas Cetus Oil, made from Texas Asphaltic Base Crude having the following characteristics:

	Paraffine Base Crude Pennsylvania Oil	Asphaltic Base Crude Texaco Cetus Oil
Color	Reddish brown	Bluish yellow
Gravity, Baume	30°	20°
Specific Gravity	.8750	.9333
Weight, lbs., per gallon	7.29	7.78
Flash point ° F.	417°	365°
Fire point ° F.	464°	390°
Chill point ° F.	32°	12°
Viscosity		
Tagliabue at 150° F.	177″	189″
Saybolt at 100° F.	186″	200″

Co-Efficients of Friction

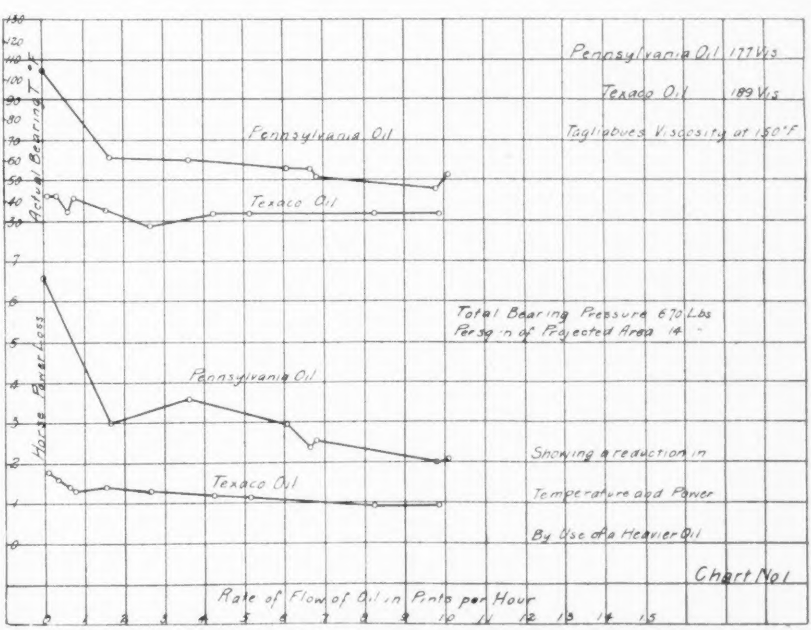
Pressure on bearing, pounds		670	2670	4670	6670	8670
Pressure per square inch projected area, pounds		14	56	97	139	181
	Rate of flow in pints per hour					
Pennsylvania Paraffine Base Oil	0.1	.15	.028	.013	.0087	.0074
	0.5	.056	.0225	.01125	.00815	.00688
	1.0	.043	.021	.0109	.0079	.0068
Texaco Cetus Oil	0.1	.0285	.0145	.009	.0077	.0064
	0.5	.0226	.0112	.0082	.00725	.0057
	1.0	.0196	.0108	.008	.0072	.00565

The co-efficients of friction from each series of tests were charted carefully, from which, for the sake of uniformity, points were taken and a second table was made, which shows the co-efficients of friction for each test at the specified rate of feed of oil of one-tenth, one-half, and one pint per hour. The preceding tabulation will show the results given by the two different oils under the same identical test conditions.

The horse power and temperature losses for each set of oils under test are shown in detail in five tables, and also shown graphically on the charts, numbered one to five, of which *Chart No.* 1 is printed herewith. These charts are made on the basis of the power and actual temperature of bearing above the temperature of the room, under the same bearing pressure and speed of journal for each oil at a different rate of flow of oil in pints per hour.

During the test with the oil made from Pennsylvania Base Crude, it was found that considerable time was consumed in allowing the machine to settle down to a state of constant conditions. Even after such a point had been reached, the data as recorded on the running log showed considerable variation, especially at low rates of feed, these discrepancies being probably due to the nature of the oil, the slight irregularities in flow allowing the film on the bearing to streak or break; the higher rates of flow overcame this difficulty to a great extent.

The heavier oil proved less troublesome in every way, for it not only took less time to bring about constant conditions, but the readings showed practically no variations during the numerous runs. Comparing the tests of the two oils under equal pressure, it will be seen that in every case the required horse power and the temperature on the heavier Texaco Oil (189″ viscosity) are less than that on the Pennsylvania Oil (177″ viscosity) reversing the former rule that less



power should be shown with the oil of less viscosity. The tests on this machine served the investigators' purpose in showing the influence on the power by the difference in the rate of flow of the lubricant.

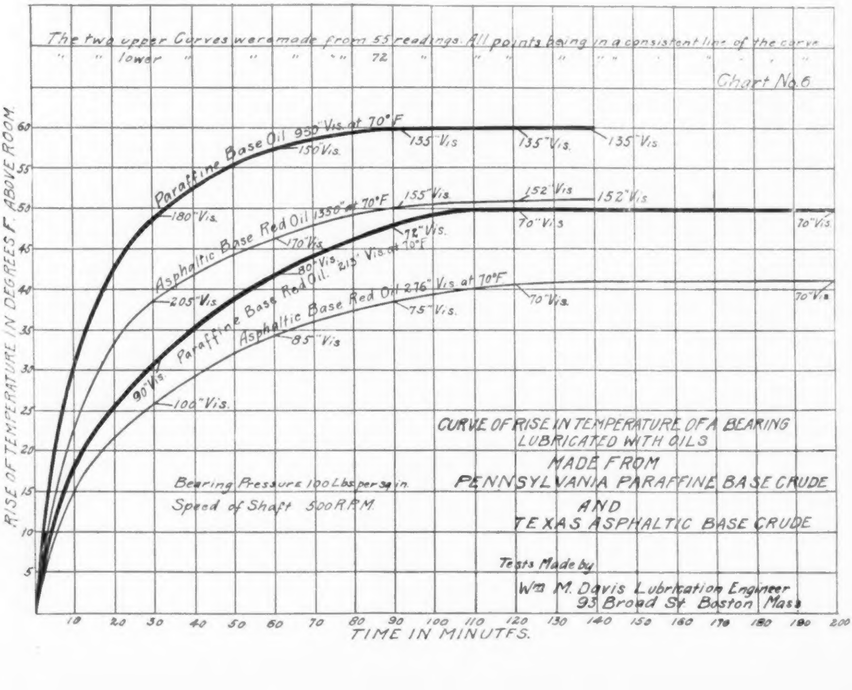
Case No. 2

Further proof of the necessary modification of the long established rule of lubrication is offered in the results of the following frictional heat test.

The observations were made on a special machine constructed to test out ball bearings. The machine consisted of a piece of two inch shafting about three (3) feet long, the ends of which were fitted in ball bearings, which in turn were fastened in ordinary shafting hangers bolted to the floor. Half way between these two bearings was suspended a third bearing by means of a steelyard upon which weights were hung. The shaft was driven by a small motor. A hole was bored in the test bearing in which oil was put and the test thermometer inserted.

The steelyard was weighted so as to make the pressure on the bearings 100 pounds per square inch, where it was maintained for the complete series of tests. The shaft was driven 500 revolutions per minute for all tests. The temperature of the bearing above the temperature of the room for the four series of tests is graphically shown on *Chart No.* 6.

To make the matter quite complete the viscosity of each oil, is noted by the *Chart Line* at various comparative temperatures. Four (4) complete tests were made working with two (2) Paraffine Oils of considerable variation in viscosity, and two (2) Asphaltic Base Oils of widely different viscosity.



The Combined Chart shows:

1st. Decreasing the viscosity of the Paraffine Base Oil decreases the temperature of the bearing.

2nd. Decreasing the viscosity of the Asphaltic Base Oils decreases the temperature of the bearing.

3rd. In comparing the Asphaltic and Paraffine Base Oils the rule must be modified, the lower temperature of the bearing being produced in one instance by a heavier bodied Asphaltic Base Oil, and in the other instance by an Asphaltic Base Oil of approximately the same viscosity.

Case No. 3

Power tests on a Whitin Spinning Frame operating on Warp, 208 spindles to the frame. The frame was driven by a special 5 H.P. Westinghouse motor and the power was recorded by an Easterline Graphic Wattmeter. Before the test on each oil the frame was thoroughly cleaned, spindle bases being pumped out and washed with kerosene, so that each oil could be tested under identical conditions. The average power, which is taken from the graphical chart with the physical characteristics of each oil tested is as follows:

This test shows that with the heavier bodied oil the frame operates with lower horse power, speeds and all other conditions being equal.

Case No. 4

This case has been dealt with in the previous issue of *Lubrication*, under the heading of "125 H.P. Otto Gas Engine Belted to a 30 Ton York Ice Machine," running at 180 Revolutions per minute, and operated by producer gas.

Case No. 5

Test on a 500 K.W. Low Pressure Horizontal Turbine, 1,500 R.P.M., 16 lbs. exhaust steam pressure. This was a difficult turbine to suit oil to, for the reason that the governor gear required, according to the makers, at least 150 lbs. pressure, and it was found that the lighter bodied oils would not give the required pressure. The best oil obtainable, until the use of the last heavy oil, was one having a viscosity of 480″ at 100° F. Saybolt. Heavier Paraffine Oils had been tried, but these heavier oils increased the bearing temperatures to points that were considered dangerous. Before making the change to the last oil, very careful tests were made of the conditions, readings being taken every

	Pennsylvania Paraffine Base Oil	Texaco Spica Oil	Reduction
Gravity, Baume	34.3°	20.5°	
Flash °F.	325°	300°	
Fire °F.	375°	340°	
Cold test °F	16°	5°	
Viscosity at 100°F., Saybolt	64″	100″	
Power (E.H.P.) averaged from graphic chart	3.885	3.610	.276 or 6.62%

half hour from nine to four o'clock on the days during tests. After this was done, the oil was removed, and Texaco Ursa Oil placed in the turbine and allowed to run for some time, after which the same observations were made. The average results of the entire test are as follows:

	Paraffine Oil	Texaco Ursa	Difference
Gravity, Baume	24.3°	18.5°	
Flash °F	400°	355°	
Fire °F	450°	430°	
Cold test °F	40°	5°	
Viscosity at 100°F	480″	750″	
Average bearing temperature °F	123.7°	121.5°	2.2° or 1.8%
Circulation oil			
To bearings °F	128°	125.3°	
From bearings °F	132°	129°	
Difference	4°	3.7°	.3 or 7.4%
Gear pressure	117 lbs.	150 lbs.	33 lbs.
Bearing pressure	13.2	18.7	5.5
Cooling water °F	56°	56°	
Room temperature °F	95.4°	85.7°	9.7°

In this test it will be seen that the room temperature was 9.7° in favor of the reduction in bearing temperature. It was found on this particular turbine, however, that the room temperature did not greatly affect the bearing temperatures, as at many points during the entire test the room temperatures were the same, while the relative bearing temperatures remained as given in the table. This was, no doubt, owing to the bearings being water cooled.

The main point in this test, which can be taken as showing the actual frictional effect between the two lubricants, would be the difference in temperature between the oil going on to the bearing and the oil coming out of the bearing. This directly indicates the amount of *lost* energy under the two conditions of lubrication. The average rise or increase in temperature between the ingoing and outgoing Paraffine Oil was 4°F., and with the heavier oil, 3.7°F. or a reduction of 7.5%. This reduction in heat loss, while small, indicates quite clearly that the heavier oil operates at lower temperature. The fact that the Texaco Ursa Oil was heavier is shown also by the gear case and bearing pressure. Both of these pressures came from the same pump and were not affected by valve regulation, and the increased pressure of one oil over the other on each item was due entirely to the body or viscosity of the oil.

Case No. 6

This case is included simply to show that under the most extreme conditions with the highest viscosities, the conditions requiring a modification of the established rule are maintained. This case is very extraordinary as the difference in the

viscosity of the two oils is very considerable. The Pennsylvania Oil has a viscosity of 165″ at 210°F. and the Texaco Oil 485″ at 210°F. The test was made on the pinions of a 10″ Skelp Mill in a steel plant. These pinions are enclosed in a case; the bearings are 5″ in diameter by 10″ long. Speed of the different pinions is from 360 to 580 R.P.M. Over ten different kinds of oils were tried out in this pinion case. Cylinder oil was found to be the best adapted, all of the other oils would get so hot that they would boil over. The oil is placed in a cellar in the lower part of the case so that the teeth of the lower pinions are submerged. This oil is then passed from pinion to pinion and afterwards to the bearings. The following table gives full details regarding the physical characteristics of the oil, oil consumption and cost and the frictional temperatures of the pinion bearings:

	Pennsylvania Cylinder Stock	Texaco Crater Compound	Reduction
Gravity, Baume	25.5°	14.0°	
Flash °F	540°	400°	
Fire °F	600°	520°	
Cold °F	40°	35°	
Viscosity, Saybolt at 210°F.	165″	485″	
Cost per gallon	20c	48c	
Consumption per week, gallons	210	72	
Total cost	$42.00	$34.56	$7.44 or 17.7%
Temperature test averages			
Room °F	66°	66°	
Bearings °F	142°	116°	
Actual °F	76°	50°	26° or 34.2%

The results of this test are exactly the opposite to what they would have been if Pennsylvania Base Oils had been used on both tests.

Conclusions:

The series of tests described in Case No. 1 are very conclusive. These experiments were made for the purpose of securing data which would show the effect of flow of oil upon the power—fortunately two sets of oils were used for the series of tests and these oils, undoubtedly unknown to the operators, were of widely different sources of origin. The facts produced from the series of tests combined with a knowledge of what the two oils were made from (which is indicated entirely from the gravity and temperature tests on each sample tested, low gravity with comparatively lower Flash and Fire and Chill tests indicating the Asphaltic Base Oil) allowed of the use of the data in showing scientifically the fact that a heavier Asphaltic Base Oil would produce a lower co-efficient of friction than a lighter Paraffine Base Oil. This is shown all through the five tests at different bearing pressures and rates of feed of the lubricant.

The results of Case No. 2 prove that a lower temperature to the bearing is secured by use of a heavier Asphaltic Base Oil as compared to a lighter Paraffine Base Oil. The test also shows that the rule that lowering the viscosity of an oil made from any one particular base will cause a lower temperature to be shown on the bearing under observation.

This test is very interesting as it shows the basic principle of the original rule of lubrication as well as the change in ideas that is required by the introduction of a new Southern Base Oil.

The balance of the tests, which cover a very wide range of conditions, indicates quite clearly that a lower temperature to a bearing, and consequently lower power reading, can be secured by using a heavier bodied, heavier viscosity Southern Base Oil as compared to the lighter bodied, lighter viscosity Pennsylvania Paraffine Base Lubricants. This is directly opposed to the general rule of lubrication, and is only accounted for by the fact that Southern Base Crudes allow oils to be made of a greater internal lubricating power than the oils that are made from crudes from other sources. The temperature tests shown herewith were the first from an outside source that had been brought to our attention, though indications were given some time previous in some practical tests that were made with these new oils under special direction, which seemed to point to very interesting and valuable conclusions. A considerable opportunity has been given for study of the subjects in a practical way, and the cases cited show that the rule of using a heavier viscosity Texaco product as compared to a lower viscosity Pennsylvania or Paraffine Base Oil will invariably produce results which show clearly that the use of the heavier bodied, high viscosity oil has brought about all of the features which theoretically and scientifically follow the use of this particular lubricating oil.

The great technical advantages in being able to use a heavy bodied, higher viscosity oil for lubrication are obvious. Less oil of this kind will be used, as it will not flow as rapidly from the oil can or cup. In the case of textile mill work, a heavier bodied oil will not drip as rapidly from the boxes or shafting. When the plant is closed down, the heavier bodied oil will have a greater tendency to stay between the surfaces, so that in starting, the initial friction or power will be better influenced. The lighter bodied oils at times, when the machines are at rest, drip out or are pressed out between the surfaces, and high temperatures result upon starting the machines, owing to the fact that little or no oil is present between the surfaces to be lubricated during the start and until the oil boxes or cups are brought into operation. Where it is possible to use a heavier bodied oil of higher viscosity, this effect is not as pronounced.

It was many times determined, in the days when only Paraffine Base Oils were available, that to use heavier bodied oils would cause a material increase in consumption of power of nearly all classes of machines—which in many cases entirely offsets any advantage that would occur through the less consumption of oil, or the dripping or throwing features. In many classes of business, especially in the textile mill line, it was found of great advantage to use the lightest bodied oils possible, owing to the effect upon the frictional and total load. Working entirely with Paraffine Base Lubricants, a reduction in the power of a textile mill can be secured within certain high and low limits, by the use of oils of less viscosity. This reduction in power, in the majority of cases, is also coupled with a considerable increase in gallon-

age brought about from the fact that the lighter the oil in body and viscosity the easier it will flow and the more will be used. To offset this, control or allowance systems are usually established, their purpose being to reduce or limit the amount of oil that is to be used. This has sometimes a detrimental effect, inasmuch as under a strict allowance system machines may not get all of the light oil they require, and consequently the bearings will wear through surface friction, so that the total effect to the mill is a loss, the wearing of the bearings from the metal to metal friction caused from too little oil offsetting the original increase in efficiency through the reduction of power by using the lighter viscosity oil.

It is impractical on many types of machines in a mill to arrange the bearings for a continuous oiling system, so that a great quantity of the lighter oil can be continuously used. The only practical solution of the problem of reducing power, at the same time saving oil, which influences the cost, saving the wear to the bearings, and loss in damage the oil causes by dripping on the goods seems to be offered in these new oils made out of the very rich Southern Crudes, as these oils have technical advantages not possessed by oils made from Paraffine Base Stocks.

[Full copy of this article will be furnished upon request addressed to the Editorial Department.]

TEST ON A HAMILTON CROSS COMPOUND CONDENSING ENGINE

SIZE:—Cylinders 26″ and 50″ diameter x 48″ stroke.
SPEED:—100 Revolutions Per Minute.
STEAM PRESSURE:—140-145 pounds at gauge.
STEAM TEMPERATURE:—360° Fahrenheit.
SUPER HEAT:—Increased temperature from 30° to 80° Fahrenheit.
RECEIVING PRESSURE:—10 pounds at gauge.
VACUUM:—26 inches.
TEMPERATURE OF CONDENSING WATER:—50° to 60° Fahrenheit (initial).
TEMPERATURE OF CONDENSING WATER:—112° Fahrenheit (final).
RATED HORSE POWER:—1200.
ROOM TEMPERATURE:—96° to 120° Fahrenheit.
BEARING TEMPERATURE:—120° to 122° Fahrenheit.

A THOROUGH test of Texaco Lubricants was made on the above engine, which is running in a large electric light and power plant which supplies electricity for one of the largest cities in the southwest. The engine was fitted with a three-feed Hillis McCanna Forced Feed Lubricator, through which the oil was being fed to both cylinders and to the steam pipe. There had evidently been some difficulty with the lubrication, as both the high and low pressure cylinders were badly scored. This developed at an inspection made after the first run on the competitive cylinder oil, which was to be taken as a basis for this test. The competitive oil was of very good quality, and during the time previous to the test with Texaco Oils, the consumption was reduced to 0.91 quarts per hour for

the high pressure cylinder and 0.90 quarts per hour for the low pressure cylinder. It was determined positively that this amount of cylinder oil was just sufficient for proper lubrication. After observing the action of the competitive oil, the cylinders were opened and examined and were found to be cut, as stated above, although the indications were that this scoring had taken place some time previously. The general condition of the cylinders was good, as far as the evidence of the cylinder oil was concerned.

Starting January 9th, 1913, and running until January 25th, a total of 299¼ hours, the consumption of Texaco Cylinder Oil for the high pressure cylinder was 161 quarts, and during a period of 147½ hours, 64 quarts of the same oil was fed to the low pressure cylinder. This makes an average of 0.53 quarts per hour for the high pressure and 0.43 quarts per hour for the low pressure cylinder. At the end of the test of Texaco Cylinder Oil a thorough inspection of cylinders and valves was made. They showed all the evidences of perfect lubrication, all parts being covered with a good film of oil. During the days in which the Texaco Cylinder Oil was being used, it was noticed and noted on the reports that the engine was running free and easy, without the slightest indications of undue friction. It was especially noted that the sound and feeling was much better than when the same engine was operating on the competitive oil. Even with an excessive feed of the competitive cylinder oil, the pistons groaned at times. This did not occur during the use of Texaco Cylinder Oil.

The consumption of oils in quarts per hour for both tests was as follows:

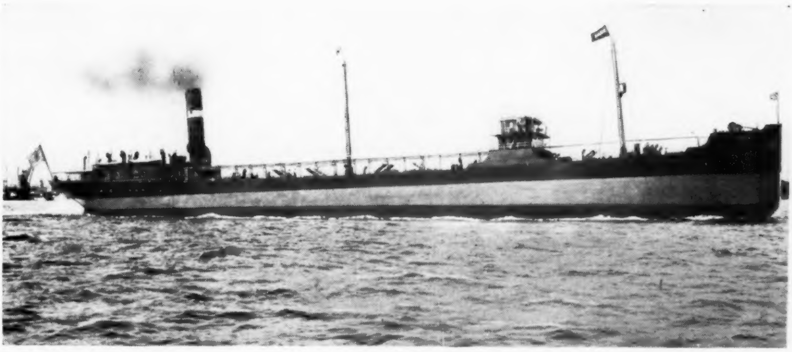
Competitive Cylinder Oil	1.82 Qts. per hour
TEXACO CYLINDER OIL................	.96 " " "
Reduction........	.86 Qts. per hour or 41.8%

THE STEAMSHIP TEXAS

IN all parts of the world, the handling of oil from the refinery to the consumer is not only a very important part of the oil business, but it has been worked out to such a degree of efficiency that the methods of distribution which obtain in the oil business undoubtedly have a most important bearing upon its low cost to the consumer. This complete system of handling and distribution extends not only to the transportation and distributing facilities in the interior for domestic purposes, but to storage and transportation facilities for ocean carrying from port to port practically all over the globe.

From the Mexican border to the northern boundary of the United States on the Atlantic and Gulf Coasts The Texas Company owns and operates a number of deep-water terminals with enormous storage capacity, warehouses for handling and packing all kinds of petroleum products, and all the other facilities for such work.

These terminals are connected with the refineries and with our distribution facilities all over the globe by our marine equipment. This fleet—used for harbor, coastwise and foreign trade, consisting of ocean-going steamers, barges, tugs, lighters and motor boats—numbers close to a hundred, with the tank-steamer *S. S. Texas*, flagship of the Texas Company's fleet as the largest and most important.



The *S. S. Texas* is usually engaged upon the coastwise trade carrying oil from the Port Arthur Terminal to the refineries and other terminals along the coast. The accuracy of runs from north to south and vice versa is so well known that this vessel has come to have the regularity of an express train. The *S. S. Texas* has a storage capacity of considerably more than 2,000,000 gallons, divided among fourteen tanks, seven each on the starboard and port side. Her equipment for loading or unloading is of the most modern character, so that an entire change of cargo can be made well within three days. This ship has one three-cylinder triple-expansion engine capable of developing 3,200 H. P. at 75 to 76 revolutions per minute, giving an average speed of eleven knots per hour. The *S. S. Texas* burns Texaco Fuel Oil and records of the steam gauges, propeller revolutions per minute, etc., show a remarkable steadiness in the steam pressure, the variations being usually slight over years of operation, and show unusual consistency of speed under all weather conditions.

These records illustrate very definitely the value of Texaco Fuel Oil as against coal for marine work, and the efficiency of the boilers and engines of the *S. S. Texas*. The engines and all of the auxiliaries have been lubricated with Texaco Lubricants since shortly after the ship went into commission. The good lubrication of the machinery has materially aided the general efficient performance of the ship.

AN ERROR

IN the last issue of *Lubrication* we published an article on "Test on 125 Otto Gas Engine, belted to a 30-Lb. Horizontal York Ice Machine," in which a typographical error was made, which we wish to correct herewith. The title should have read as follows, "Test on 125 Otto Gas Engine, belted to a 30-TON York Ice Machine." The 30 ton of course refers to the capacity of the machine.

LONG TIME RUNS

THE following readings were of great interest to us and no doubt will be appreciated by all readers of *Lubrication*. They deal with the changes which take place in oils after they have been subjected to hard usage. The case in question shows the changes in Texaco Altair Oil which have taken place during the unusual length of time this oil has run in the ring oiling bearings of a large motor generator set, the shaft of which was running 900 Revolutions Per Minute.

Altair Oil represented in sample No. 2375 has been in service 9,000 hours.

Altair Oil represented in sample No. 6158 has been in service 15,505 hours.

It will be seen that the flash and fire tests of the oils have increased slightly, as is usual in cases of this kind. The pour test has been slightly affected; the viscosity has arisen from 550″ to 682″, a difference of 123″, after 9,000 hours run, and to 824″ a difference of 274″ after 15,505 hours run, which variation, considering the number of hours that the oil had been working at such high speed, is quite inconsiderable. The acidity of the oil in the case of the new oil is 0.037% as SO_3, an allowable amount for a strictly neutral, free from acid oil. At the end of the 9,000 hour run the acidity had increased to .096% and at the end of 15,505 hours to .10% as SO_3. This increase indicates in a measure the oxidization of the oil. The amount of 0.10% is so inconsiderable that it would not show the slightest action on any metal.

Special tests were made to see if this oil, after such a lengthy run, had developed any tendency towards throwing out a deposit. The Naphtha test showed that there was no precipitant with the new oil. The precipitant represented by .29% and .38% is reported as being a peculiarly flocculent, light brown material, and not of asphaltic nature. The alcohol ether test developed a light brown precipitant of a fluffy character, which was in no way related to asphalt in any form.

Following are the results of the examination:

Sample Number Hours Service	New Oil	2375 9,000	6158 15,505
Gravity °B	18.9	19.5	18.9
Flash °F	350°	380°	375°
Fire °F	420°	430°	435°
Pour Test °F	5°	10°	10°
Color	140	Too dark	Too dark
Viscosity, Saybolt at 100°F	550″	682″	824″
Acidity SO_3	0.037%	0.096%	0.10%
Appearance	Red	Dark red	Dark red; brown by reflected light
Odor	Normal	Normal	Neutral
Water	....	...	Trace

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